

**Physics 1710**  
**Review Summary**  
**Essential Facts and Concepts**  
**Unit 1 Kinematics and Vectors**

- Units:
  - Time—second
    - (1/60)(1/60)(1/24) mean solar day
    - approximately  $9 \times 10^9$  (exactly 9 192 631 770) times the period of the oscillation of a  $^{133}\text{Cs}$  atom
  - Distance—meter
    - Circumference of earth is  $4.0 \times 10^7$  m
    - 1 meter = (c (1/299 792 458 second), c is velocity of light, about 300 million m/s ( $3 \times 10^8$  m/s).
  - Mass—kilogram
    - Mass of 1 liter ( $0.001 \text{ m}^3$ ) of water
    - Mass of standard kilogram specimen
- Measurement:
  - Precision—the fineness of the measurement
  - Accuracy—the nearness to an (unknown) true answer
  - Significant figures—the accurately known digits in a measurement:
    - Multiplication—keep same number of sig figs as *least* significant factor.
    - Addition—round to same number of decimal places before adding or subtracting
  - Scientific notation  $n.nnnnnnn \times 10^p$
  - Prefixes:
    - f— $10^{-15}$ ; p— $10^{-12}$ ; n— $10^{-9}$ ;  $\mu$ — $10^{-6}$ ; m— $10^{-3}$ ; c— $10^{-2}$ ; d— $10^{-1}$
    - k— $10^3$ ; M— $10^6$ ; G— $10^{12}$ ; T— $10^{15}$
  - Mass density:  $\rho = m/V$
  - Avogadro's Number:  $N_A = 6.022\,14199 \times 10^{23}$
  - Atomic Mass Unit =  $0.001 \text{ kg} / N_A \sim 1.66 \times 10^{-27} \text{ kg}$
- 1-D Motion (a special case of 2-D motion)
- 2-D Motion
  - position  $\mathbf{r} = (x,y)$
  - average velocity  $\langle \mathbf{v} \rangle = \Delta \mathbf{r} / \Delta t$
  - average acceleration— $\langle \mathbf{a} \rangle = \Delta \mathbf{v} / \Delta t$
  - instantaneous velocity— $\mathbf{v} = d\mathbf{r}/dt = d^2\mathbf{r}/dt^2$
  - instantaneous acceleration— $\mathbf{a} = d\mathbf{v}/dt$
  - $\mathbf{a} = (a_x, a_y) = a_x \mathbf{i} + a_y \mathbf{j}$  = uniform:  $\mathbf{r} = (x,y) = x\mathbf{i} + y\mathbf{j}$ ,  $\mathbf{v} = (v_x, v_y) = v_x \mathbf{i} + v_y \mathbf{j}$ 
    - $\mathbf{v} = \mathbf{v}_{initial} + \mathbf{a} t$
    - $\mathbf{r} = \mathbf{r}_{initial} + \mathbf{v}_{initial} t + \frac{1}{2} \mathbf{a} t^2$
    - $v_x^2 = v_{x, initial}^2 + 2a_x x$
    - $v_y^2 = v_{y, initial}^2 + 2a_y y$
  - Centripetal Acceleration  $\mathbf{a} = -\omega \mathbf{r}$ ;  $a = v^2 / r$

- Bodies in freefall under the action of gravity alone follow a parabolic trajectory.
- The acceleration due to gravity is  $\mathbf{a}_g = -\mathbf{g}$ , where  $g = 9.80 \text{ N/kg} = 9.8 \text{ m/s}^2$
- Vectors
  - The sum of vectors  $\mathbf{A}$  and  $\mathbf{B}$  is  $\mathbf{A} + \mathbf{B} = \mathbf{C}$ , where  $C_x = A_x + B_x$  and  $C_y = A_y + B_y$
  - The product of a scalar  $m$  and a vector  $\mathbf{A}$  is  $m\mathbf{A} = \mathbf{C}$ ,  $C_x = m A_x$  and  $C_y = m A_y$
  - The magnitude of a vector  $\mathbf{C}$  is  $|\mathbf{C}| = \sqrt{[C_x^2 + C_y^2]}$
  - The vector makes an angle  $\theta$  with the x-axis such that  $\tan \theta = C_y / C_x$
- Laws of Motion and Force
  - 1<sup>st</sup> Law
    - A net external force is what causes the acceleration of a body.
    - When there is zero acceleration there is no net external force.
  - 2<sup>nd</sup> Law
    - $\mathbf{a} = \mathbf{F}/m$
    - The acceleration that results from a force is equal to the force divided by the mass of the body on which the force acts and in the direction of the force.
  - 3<sup>rd</sup> Law
    - If one body exerts a force on a second body the second body exerts a force on the first body equal in magnitude and opposite in direction.
    - $\mathbf{F}_{12} = -\mathbf{F}_{21}$
- Friction
  - Force due to friction:  $F_f = -\mu N$ ,  $\mu$  is the coefficient of friction,  $N$  the normal (perpendicular) force.  $0 < \mu < 1$ .
  - The angle of repose  $\theta_{repose}$  is the maximum angle of an incline for which a body resting (reposing) on that surface can remain stationary.  
 $\theta_{repose} = \tan^{-1} \mu$